March 14, 1944. J. C. SHAW 2,343,869

CONDITIONER FOR CONGEALABLE LIQUIDS

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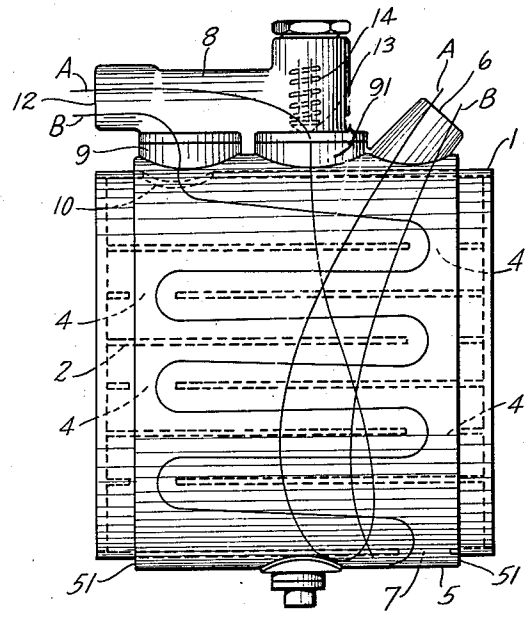


Fig.-1

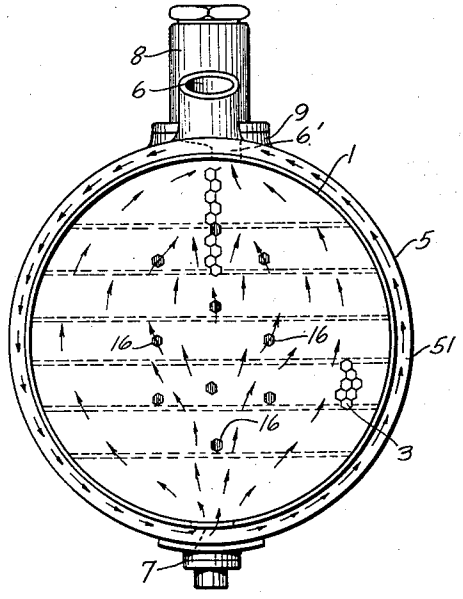


Fig.-2

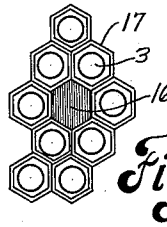


Fig.-3

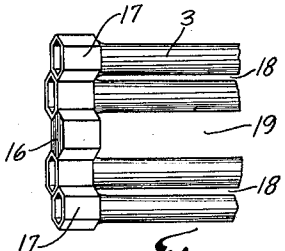


Fig.-4

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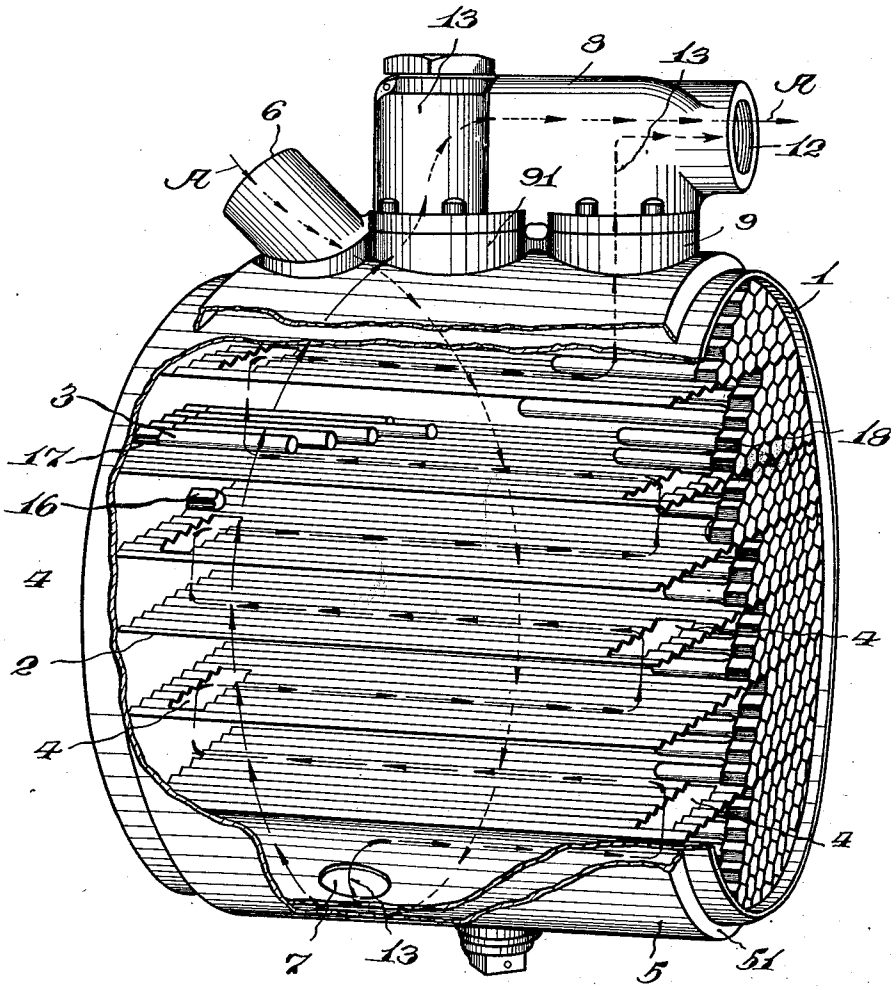
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Fig. 5



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CONDITIONER FOR CONGEALABLE LIQUIDS

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9 Claims. (Cl. 257—2)

This invention relates to conditioners for congealable liquids and more definitely, to an oil conditioner having particular utility in connection with internal combustion engines.

While the device herein proposed will be seen to be useful as a heat-exchanger in other fields, the primary object thereof is to obtain and maintain proper viscosity in the lubricating oil for an internal combustion engine, not only during the starting period, when the main body of the oil is cold, but also during the subsequent running period when excess heat must be dissipated. Hence, it is intended to provide a conditioning device partaking of a dual characteristic, namely, that of a heat distributor and conservator on the one hand, and that of a heat radiator on the other hand. Furthermore, it is an object to provide a device whose operating characteristics automatically vary in accordance with the condition of the liquid being treated; that is, when the oil is highly viscous, the apparatus functions to distribute heat throughout the oil without substantial heat loss through radiation, and as the viscosity of the oil decreases with a proportionate rise in temperature, the apparatus accordingly dissipates excess heat through radiation.

Still another object is to provide a conditioner for congealable liquids adapted to be placed in the oil circuit of an engine or the like and which, while having a number of heat-exchange elements subjected to relatively high oil pressures when the oil is congealed, nevertheless, will not be damaged by such high pressures, even though the elements be disposed directly in the path of the congealed oil. In order that damage from pressure be averted, it is an object to define certain channels between the heat-exchange elements for offering relatively low resistance to the passage of congealed oil. More specifically, it is now proposed to provide, in a congealable liquid conditioning device, a radiator body having a plurality of heat-exchange elements disposed therein in spaced relation to one another, the radiator body initially containing a mass of congealed lubricating oil packed between the elements and having an inlet and outlet adapted to be connected in the oil circuit of an engine so that, when the engine is started, hot oil flowing from the engine is passed in heat-transfer relationship adjacent to and through the mass of congealed oil. According to this invention, the spacing between the heat-exchange elements is such that, when the hot oil from the engine is first forced through the inlet and against the mass of congealed oil, the hot oil will "break through" along certain tortuous, but well-defined paths of low flow resistance. Once flow of the hot oil through the mass of congealed oil is established, it necessarily follows that the congealed oil adjacent the flow paths will soon become heated sufficiently so that a quick succession of "breaks" through the channels of relatively great resistance to flow will follow.

A further object of the invention is to provide an apparatus which, while functioning as a radiator type oil cooler, may not be blocked by congealing of oil therein when exposed to extremely low temperatures. Thus, when this device is used on aircraft engines, even though it might suddenly be cooled so that the oil adjacent some of the heat-exchange elements would congeal, relatively wide passages always will remain open to maintain communication therethrough without appreciable increase in pressure on the intake side or pressure drop at the outlet. Thus, it is intended to provide, in a congealable liquid conditioner, for the maintenance of constant pressure throughout substantially all operating conditions and, as a corollary, the maintenance of flow.

Yet again, it is hereby intended to provide a conditioner which, while functioning primarily as a radiating cooler for hot liquid flowing therethrough, necessarily subjects such oil to cooling in transit, as opposed to previously developed coolers having alternate flow paths offering comparatively high and low resistance, respectively, but wherein, when the liquid negotiates the path of low resistance, practically no cooling results.

An additional object is to provide a conditioner for congealable liquids, such as lubricating oil, adapted to be exposed to a cooling medium, such as air, and which, when a substantial portion of the liquid therein is congealed, presents relatively little effective area to the cooling medium, but which, when the liquid is more fluid, utilizes its entire cooling facilities.

Structurally, the objects of this invention are manifest in a conditioner having a main generally cylindrical body with an inlet through one side thereof, outlets on the opposite side, and a plurality of air passage tubes extending axially therethrough. Among the specific objects is the spacing of the tubes from one another so as to provide certain tortuous paths of relatively low resistance. A dominant characteristic of the low resistance paths, which are of large cross-section, is that they communicate at every turn with paths of less cross-section and higher resistance so that the hot oil always seeks out the congealed.

Another structural feature of the invention is the formation of reticulated end walls for the main body of the radiator element by providing spacer elements at the ends of the air passage tubes, the spacer elements being of angular outline so as to inter-fit with one another so that the tube elements and their surrounding spacer elements form substantially self-sustaining end walls. At certain intervals it is intended to provide, instead of a tube and its surrounding spacer

element, a plug preferably with an outline similar to the spacer elements, so as to form a relatively wide channel therebehind.

Along with the structural aspects of this invention it is intended to teach the method of conditioning a congealable liquid by passing hot portions of the liquid along tortuous paths through congealed portions of the liquid.

These and other objectives will appear from the following specification and drawings, in which:

Fig. 1 is a side elevation diagrammatically illustrating the invention;

Fig. 2 is an end elevation;

Fig. 3 is an enlarged fragmentary view of an end wall;

Fig. 4 shows a fragment, in perspective, of the tube ends; and

Fig. 5 is a fragmentary perspective view, partly in section, showing the construction of and the oil flow paths in the congealable liquid conditioning device.

Referring now to the drawings, reference numeral 1 denotes a cylindrical shell preferably formed of sheet metal and surrounding the main body portion of the conditioner, the inner elements of which form a core section broadly of the type found in radiators and oil coolers for internal combustion engines for automobiles, airplanes and other vehicles.

Inside shell 1, a plurality of baffles 2 are disposed in parallel spaced relation to one another, the baffles extending from end to end of the shell and preferably being of sheet metal secured at their edges to the inner side of shell 1. As seen in Figures 1 and 5, each of the baffles is formed adjacent one of its ends with openings disposed in staggered relation to the openings in adjacent baffles so as to provide inter-connecting ports 4 therebetween and to define a zigzag passage through the core and in which zig-zag passage the liquid flows substantially parallel to the flow of coolant through the main body portion of the conditioner.

The core structure further includes a plurality of heat-exchange elements in the form of air tubes 3 dispersed throughout the interior of shell 1 and extending axially therethrough from end to end, the ends of the tubes being open so as to allow coolant, such as air, to pass freely therethrough. The tubes are supported in spaced relation to one another by spacer elements or by enlarged or flared integral portions at their ends, described more fully below, so that the spaces 18 and 19 between the tubes cooperate to form myriad tortuous passages.

Surrounding shell 1, a cylindrical jacket 5 is supported in radially spaced relation to the shell by end walls 51 extending between the outer side of shell 1 and the ends of jacket 5, so as to define an annular chamber surrounding the shell, the chamber constituting a feed chamber or oil passage and having an inlet 6 adapted to be connected to an oil line (not shown) leading from a motor.

In its lower side, as seen in Figs. 1, 2 and 5, shell 1 is provided with an inlet opening 7 so that the interior of the core section within the shell communicates with the chamber enclosed between shell 1 and jacket 5, the inlet 7 preferably being diametrically opposite inlet 6.

The outlet elements for the chamber between shell 1 and jacket 5, and for the main body of the core section inside shell 1, are formed in valve mechanism 8 mounted on bosses 9, 91 which are affixed on the outside of jacket 5 and which surround openings through the jacket. As seen best in Fig. 1, an outlet 10 extends through the wall of shell 1 immediately opposite the opening in jacket 5 surrounded by boss 9 so as to establish communication from the interior of shell 1 through an outlet conduit 12 in valve mechanism 8, conduit 12 being, in turn, adapted for connection with an oil line (not shown) leading back to an engine. Valve mechanism 8 is completed by a valve 13 movably mounted to close the opening through boss 91 and normally biased towards closed position by spring 14, which may be of the simple expansion type diagrammatically illustrated, and so adjusted as to yield under a predetermined amount of pressure from within for allowing the valve to open, or of the thermostatic type and arranged to close and open the valve, respectively, in the presence or absence of predetermined heat.

The operation of the structure thus far described is as follows: Assuming the conditioner is connected in an oil line of an internal combustion motor, and that the interior of shell 1 is packed with cold, congealed oil, warm oil from the engine, when started, will pass through chamber inlet 6 and around the chamber between shell 1 and jacket 5 as indicated by the outermost arrows in Fig. 2, unidirectional flow being provided by a boss 6' extending into the chamber. The interior of shell 1 being, at this time, momentarily blocked by the congealed oil packed between the baffles 2 and between tubes 3, sufficient pressure will be imposed upon valve 13 to overcome spring 14 so that the outlet surrounded by boss 91 will be opened, thus establishing a flow circuit generally indicated by line A. However, as the oil within shell 1 is heated by the oil flowing around the surrounding chamber, the viscosity thereof will be reduced so that passages between the tubes 3 will become established, thus to allow the oil to flow from inlet 7 through the core and out through outlet 10. Simultaneously, as the oil becomes heated and less viscous, the pressure against valve 13 will be alleviated so that spring 14 will close the valve, whereupon, the flow circuit will be as indicated by line B in Figs. 1 and 5, and the inner arrows in Fig. 2. Since the viscosity of the oil decreases as the temperature rises, the spring 14, if it be thermostatic as suggested may be adjusted to close valve 13 when exposed to heat sufficient to warm the oil within shell 1.

In order to establish certain flow paths of greater or lesser resistance to flow through the core structure within shell 1, the tubes 3 are, in certain areas, so spaced from one another so as to provide passages 19 of considerable greater cross-section than the passages 18 between most of tubes 3, these passages having comparatively little resistance to the flow of oil therethrough.

As seen best in Figs. 3, 4 and 5, flared hexagonal ends 17 are formed on each end of the tubes 3, the spacer elements 17 inter-fitting with one another and being connected to form the closed portion of the end walls of the core. However, at certain intervals, a tube 3 is omitted and a hexagonal plug 16 is appropriately substituted for the missing tube, head or nipple so that when the core is viewed from the end, as in Fig. 2, it will be seen that a pattern of devious wide passages is provided. preferably although not necessarily through the central portion of the core instead of forming the ends of the tube 3 with

integral hexagonal flared ends, the tube ends may be spaced in other ways as will be apparent.

When oil first begins to flow through the main body of the core within shell 1, it will form passages through the remaining congealed oil along the lines of least resistance, such lines being demarked from point to point by the relatively wide passages 19 between tubes 3. However, since many narrow passages 18 deviate from each wide one, the number of flow passages constantly will be increased as the hot oil seeks out other passages more directly in line with its momentary courses, and meanwhile, the oil adjacent shell 1 will have absorbed heat from the oil flowing through the surrounding chamber, so that free communication through all of the channels 18 and 19 will rapidly be obtained.

While the invention has been described as applied to an oil circuit for an engine, its application as a conditioner for congealable liquids is universal wherever the problem of bringing such liquid from a congealed to a fluid state in the minimum of time is present, and where it is desired to insure against congealing or blocking during operation. Additionally, the concept and technique of establishing the tortuous flow paths of low resistance through the main body of congealed liquid so as to seek out the remaining congealed liquid along ever-expanding, constantly shifting courses is not limited to the specific disclosure, but is to be construed to cover the full scope of the following claims.

I claim:

1. A lubricant conditioning device for use in a lubricant circulating system wherein a lubricant, the viscosity of which varies progressively with change in temperature, is circulated under pressure and subjected to heat, including a radiator body having an inlet and an outlet, means extending through the body for conducting a cooling medium in heat exchange relationship with the lubricant therein, means within the radiator body for dividing the body into a plurality of interconnected compartments and for directing the lubricant through a tortuous course including flow paths substantially parallel to the flow of cooling medium, and means for mounting the cooling medium conducting means in varying spaced relation to each other so as to provide predetermined intercommunicating lubricant flow paths of different cross-sectional areas thereby providing greater and lesser resistance to the passage of lubricant through the tortuous course from the inlet to the outlet of the radiator body so that the liquid flowing through the body tends to seek and flow toward and through the flow paths of lesser resistance to flow.

2. A lubricant conditioning device for use in a lubricant circulating system wherein a lubricant, the viscosity of which varies progressively with changes in temperature, is circulated under pressure and subjected to heat, including a radiator body having an inlet and an outlet, means for conducting lubricant under heat and pressure to said inlet, said lubricant conducting means being in heat exchange relation with lubricant in the radiator body, means extending through the body for conducting a cooling medium in heat exchange relationship with the lubricant therein, means within the radiator body for dividing the body into a plurality of interconnected compartments and for directing the lubricant through a tortuous course including flow paths substantially parallel to the flow of cooling medium, and means for mounting the cooling medium conducting means in varying spaced relation to each other so as to provide predetermined intercommunicating lubricant flow paths of different cross-sectional areas thereby providing greater and lesser resistance to the passage of lubricant through the tortuous course from the inlet to the outlet of the radiator body so that the liquid flowing through the body tends to seek and flow toward and through the flow paths of lesser resistance to flow.

3. A lubricant conditioning device for use in a lubricant circulating system wherein a lubricant, the viscosity of which varies progressively with changes in temperature, is circulated under pressure and subjected to heat, including a radiator body having an inlet and an outlet, means for conducting lubricant under heat and pressure to said inlet, said lubricant conducting means being in heat exchange relation with lubricant in the radiator body, means extending through the body for conducting a cooling medium in heat exchange relationship with the lubricant therein, means within the radiator body for dividing the body into a plurality of interconnected compartments and for directing the lubricant through a tortuous course including flow paths substantially parallel to the flow of cooling medium, means for mounting the cooling medium conducting means in varying spaced relation to each other so as to provide predetermined intercommunicating lubricant flow paths of different cross-sectional areas thereby providing greater and lesser resistance to the lubricant through the tortuous course from the inlet to the outlet of the radiator body so that the liquid flowing through the body tends to seek and flow toward and through the flow paths of lesser resistance to flow, and means for maintaining pressure on the incoming lubricant and for relieving said pressure when the latter reaches a predetermined maximum.

4. A liquid conditioning device for use in a liquid circulating system wherein a liquid, the viscosity of which varies progressively with changes in temperature, is circulated under pressure and subjected to heat, including a radiator body having an outlet, and having a passage for circulation of the liquid, and through which passage the liquid flows in heat exchange relationship with a cooling medium, means within the radiator body for dividing the body into a plurality of interconnected compartments and for directing the lubricant through a tortuous course including flow paths substantially parallel to the flow of cooling medium, means for mounting the cooling medium conducting means in varying spaced relation to each other so as to provide predetermined inter-communicating lubricant flow paths of different cross-sectional areas thereby providing greater and lesser resistance to the passage of lubricant through the tortuous course from the inlet to the outlet of the radiator body so that the liquid flowing through the body tends to seek and flow toward and through the flow paths of lesser resistance to flow, and a warm liquid conduit having an inlet and a pair of spaced outlets, one of said conduit outlets forming an inlet to the radiator body, said conduit outlets being so positioned with respect to the conduit inlet that a portion of the heat of the warm liquid flowing through the conduit will be transferred to the liquid in the radiator body before said warm liquid passes through any of said outlets, and means disposed between the conduit outlets for relieving the pressure on the warm

liquid flowing through said conduit when the pressure exceeds a predetermined maximum.

5. A liquid conditioning device for use in a liquid circulating system wherein a liquid, the viscosity of which varies progressively with changes in temperature, is circulated under pressure and subjected to heat, including a radiator body having an inlet and an outlet, a warm liquid conduit disposed in heat exchange relationship with said body and having an inlet and a pair of outlets, one of the outlets of the warm liquid conduit being connected to the inlet of the radiator body, a plurality of spaced means within the radiator body formed so as to provide a conduit for the passage of a coolant therethrough and for the passage therearound of the liquid to be conditioned, certain of said coolant conduit means being spaced from each other so as to provide liquid flow paths therebetween of cross-sectional area which afford relatively high resistance to the passage of liquid therethrough, and certain others of said coolant conduit means being spaced from each other so as to provide liquid flow paths therebetween of greater cross-sectional area and of lesser resistance to the flow of liquid than the resistance to flow occurring between the first-mentioned coolant conducting means, whereby the liquid flowing in the high resistance flow paths will seek and flow toward and through the low resistance flow paths in its passage through the body between the inlet and outlet thereof, and means mounted within the body for causing all of the liquid therein when conditioned for such flow, to move in a tortuous course comprising a plurality of interconnected paths each of which latter being substantially parallel to the axis of the coolant conduit means.

6. A liquid conditioning device for use in a liquid circulating system wherein a liquid, the viscosity of which varies progressively with changes in temperature, is circulated, under pressure and subjected to heat, including a hollow body having an inlet and an outlet, means extending through said body for conducting a coolant into heat exchange relationship with the liquid flowing therethrough, said coolant conducting means being arranged in predetermined spaced relation with respect to each other so as to provide a plurality of intercommunicating liquid flow paths of varying cross-sectional area interspersed throughout the body so as to offer relatively high and low resistance to the flow of liquid longitudinally therethrough, said high and low resistance flow paths extending substantially parallel to the flow path of the coolant, and means for mounting said coolant conducting means in said body whereby, under low temperature conditions liquid of increased viscosity flowing through the body between the inlet and outlet thereof will tend to seek and flow toward and along said paths of low resistance.

7. A liquid conditioning device for use in a liquid circulating system wherein a liquid, the viscosity of which varies progressively with changes in temperature, is circulated under pressure and subjected to heat including a hollow body having an inlet and an outlet, means extending through said body for conducting a coolant into heat exchange relationship with the liquid flowing therethrough, means to mount certain of said coolant conducting means in spaced relationship to each other so as to provide flow paths therebetween of cross-sectional area which afford relatively high resistance to the passage of liquid therethrough, and means to mount others of said coolant conducting means so as to cooperate with the first named coolant conducting means to provide liquid flow paths of greater cross-sectional areas and of lesser resistance to the flow of liquid than the resistance to flow occurring between the first-mentioned coolant conducting means, and interspersed throughout the flow paths of relatively high resistance, said relatively high and lesser resistance flow paths extending substantially parallel to the flow path of the coolant, whereby the liquid flowing in the high resistance flow paths will seek and flow toward and through the low resistance flow paths in its passage through the body between the inlet and outlet thereof.

8. A liquid conditioning device for use in a liquid circulating system wherein a liquid, the viscosity of which varies progressively with changes in temperature, is circulated under pressure and subjected to heat, including a hollow body having an inlet and an outlet, means extending through said body for conducting a coolant into heat exchange relationship with the liquid flowing therethrough, means to mount certain of said coolant conducting means in spaced relation to each other so as to provide flow paths therebetween of cross-sectional areas which afford relatively high resistance to the passage of liquid therethrough, means to mount others of said coolant conducting means so as to provide liquid flow paths of greater cross-sectional area and of lesser resistance to the flow of liquid than the resistance to flow occurring between the first-mentioned coolant conducting means, whereby the liquid flowing in the high resistance flow paths will seek and flow toward and through the low resistance flow paths, and means for causing the liquid to flow in a tortuous course comprising a plurality of interconnected paths each of which latter being substantially parallel to the longitudinal axis of the coolant conducting means.

9. A liquid conditioning device for use in a liquid circulating system wherein a liquid, the viscosity of which varies progressively with changes in temperature, is circulated under pressure and subjected to heat, including a hollow body having an inlet and an outlet, means extending through said body for conducting a coolant into heat exchange relationship with the liquid flowing therethrough, said coolant conducting means being arranged in predetermined spaced relation with respect to each other so as to provide a plurality of intercommunicating liquid flow paths of varying cross-sectional area interspersed throughout the body so as to offer relatively high and low resistance to the flow of liquid longitudinally therethrough, and means for mounting said coolant conducting means in said body whereby, under low temperature conditions liquid of increased viscosity flowing through the body between the inlet and outlet thereof will tend to seek and flow toward and along said paths of low resistance, said last named means being disposed so as to cause the liquid to flow in a tortuous course comprising a plurality of interconnected paths each of which latter being substantially parallel to the longitudinal axis of the coolant conducting means.

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